MY CRITERION DOES NOT "PROVIDE INSURANCE" IN SENSE OF ASSURING THAT ONE WILL AVOID LOSS, OR WILL AVOID REGRET, EVEN "MAXIMUM REGRET." (OR MAXIMUM LOSS(. IT PENALIZES AMBIGUITY, LEADS ONE TO AVOID AMBIGUITY--WHERE POSSIBLE WITHOUT "EXCESSIVE" LOSS IN TERMS OF BEST-GUESS EXPECTED UTILITY OR MOST FAVORABLE DISTRIBUTION.

If you follow Schlaiffer procedure and maximize mathematical expectation, you will never disobey the axioms. Even if you don't do this explicitly, you will not disobey the axioms so long as it possible to interpret your choices as maximizing a mathematical expectation. What ~~xx~~ axioms rule out are choices that would make it impossible to describe choices in terms of maximizing expected utility.

Those who have emphasized problems of reasonable belief, ways it is reasonable to think, have made distinctions that have not generally appeared among those who have concentrated on problem of reasonable behavior; if we agreed that latter theorists had solved their problems adequately, we could conclude that these distinctions "don't make a difference" in terms of actual behavior, andc ould be ignored. But theories of behavior suffer from lack of just these distinctions (Smith has introduced them in discussion of betting behavior.

What to do when probabilities are not "known"? What is the meaning of saying that any probability is "known" or "unknown"; is this meaningful with subjective probabilities? Good; Keynes; (Shackle, Knight; mere absence of "objective" probabilities. de Finetti; subjective probs cannot be unknown.

~~Px~~ Vagueness, "inconstancy."

Partial ordering; lack of comparability. Koopman.

Possibility to imagine similar phenomena in terms of choices among bets; but Savage, etc. rule it out as unreasonable, violating axioms; axioms imply complete ordering of events. Or; could infer such phenomena as related to decision rules, acting upon upper and lower probs.

How to deal with upper and lower utilities.

Interpret Y^o in terms of conflict between advisors, forecasters.

I wish to deal precisely with ~~the notion~~ problems of of vagueness, and by that I do not mean to deal with it as if it were precise.

What judgements and actions can be based upon probability judgements in the form of inequalities and a partial ordering? Answer: nearly everything; fortunately, since that's all we usually have; and recommendation that people should act so that we could infer complete ordering is dubious and will be rejected.

The Consequences of Vagueness (Ambiguity for Choice.

Minimax rule when probs are not "known"; does not require probs to be meaningful; but is not acceptable when degrees of belief are "known," or even when some degrees of belief (extremely high degrees for "bad" events(can be ruled out.

What are reasonable ways to act on the basis of incomplete information? (Rule out: ~~px~~ buying more information, avoiding decision(. Includes problems of "making inferences, statements" as well as actions. Not necessary to regard statistics as involving action, but statisticians who have chosen to look at their problems that way have contributed greatly to theory of reasonable action. Good.

Notion that probabilities may be ~~"known" would~~ "unknown" would be regarded as obviously meaningful until recently.

Suppes and Davidson: at least two variables involved, relative preference for outcomes and relative likelihood of outcomes.

Difficulty of framing meaningful descriptions or recommendations lacking measurements of these two factors. The assumption that these are the *only* factors that need be measured leads to great simplification in the process of measurement, holds out hope of simple, meaningful propositions, simpler recommendations.

e.g., can measure all probabilities by comparing acts which offer same two outcomes. Axioms ensure that "likelihood relationship" will have properties of "probability relationship" and can be expressed by numerical probabilities.

Use for purposes of measurement emphasize empirical significance of axioms as descriptive (from this point of view, it's not clear to me why axiomatization is important, unless you propose to test axioms independently.

Even there it would be useful to have some notions of when theory is more likelyto be useful.

~~Note~~ Compared to ~~S~~ von Neumann and Morgenstern and even Ramsey, Savage-Raiffa-Schlaiffer put much more emphasis on normative aspect of theory, and use of it to determine one's own decisions (rather than to predict another's decisions.

This amounts to saying that only these two variables *should* influence decision; that other variables should influence decision, if at all, only *through* these (i.e., vagueness may influence shape of probabilities. Thus, where *shape* of probability function is constant, utilities are constant (same outcome... then choice is determined, should be constant.

Theory with upper and lower probabilities would have some degrees of freedom; bets on an event would not *determine* bets against it, but would place some constraints on them--limit the upper probability of the complementary events.

Note: if theory were purely descriptive, no crisis would be involved in asserting that behavior occasionally diverged from it, or even that there were systematic deviations in specific situations, involving excluded variables; the decision-makers themselves would have no stake in this theoretical dispute...they wouldn't care which theory were used to describe their choices.

But in this case the normative interpretation of the axioms puts a challenge to these deviantsthat they "ought" to change their behavior to conform. Theory does not dictate choice of probs and payoffs, but it does rule out behavior that cannot be described at all in terms of maximizing expected utility --SPECIFY SUCH BEHAVIOR. Question here is: not, do people behave this way, but is it reasonable? In caseswhere choices plus axioms determine future behavior--i.e., determine a unique set of probs and utilities--theory says that variation among problems that does not correspond to variation in probs and utilities SHOULD NOT influence decision; should be ignored. I say this is *unreasonable*. A USEFUL NORMATIVE THEORY MUST ALLOW FOR THE INFLUENCE OF VARYING LEVELS OF THE "WEIGHT OF EVIDENCE." AND "CONFLICT"; ..together, AMBIGUITY.

1. How to Gamble If You Must. What is a reasonable way to choose among bets; recognizing that practically all important decisions are bets; including the decision not to gamble (in terms of opportunity costs, at least.

Morgan. Missiles. Procurement. R&D.

Note~~s~~ that uncertainties appear to be of different order, involving different amount of experience, etc.

Payoff matrix. Minimax.

2. A theory of reasonable behavior will have many customers. But how will we tell when we have a good one; how will we tell a bad theory from a better one?

Certain criteria: meaningfulness, applicability, convenience. Marschak article: a: general opinions; b: long-run success. But we shall look for rules of consistency, logic-like rules that will enable decision-maker to *deduce* complicated decisions from judgements and preferences that he is able to formulate relatively easily, unambiguously, confidently. If he is to trust its implications when he cannot form direct judgements, these rules must not lead to recommendations that run counter to his *best judgement* insituations when he *can* form a direct opinion. (If he finds that occasionally the theory conflicts with his immediate, casual judgements, but that on such occasions he finds that he wants to change those judgements, so much the better for the theory; this is another use of it.

Assign probabilities, preferences to those events and outcomes with which he has most experience; then deduce complicated preferences.

Need standards of consistency among beliefs; so that we can deduce beliefs from other beliefs.

3. Savage, Ramsey, Schlaifer theory.

Assign utility numbers, values, to consequences; and probability numbers to events; and take the act with the highest expected value.

Old theory: use money values for utilities; Bernoulli refuted (by hypothetical example; people wouldn't want to follow this

Same problem with probabilities: Bayes definition; but needs utilities.

von Neumann-Morgenstern approach with utilities; deduce them from behavior, on assumption that people are following this rule; Is it possible to find a set of numbers such that expected values reflect actual preferences? Yes, on certain conditions.

Ramsey-Savage method: do same with probabilities; find numbers that correspond to actual preferences.

4. Basic notion: (abstract from utility problems: WHEN YOU CHOOSE BETWEEN ACTIONS WHICH OFFER THE SAME TWO OUTCOMES, YOU WILL CHOOSE THE ACTION THAT OFFERS THE HIGHEST PROBABILITY OF THE PREFERABLE OUTCOME.

No utility problems; should result whatever the "relative preference" between these two.

Thus, we get judgements of relative probability; and in case of an n-scale, we get numerical probabilities; with complete ordering, all probabilities are numerical.

But what guarantees that: we will be able to compare all events; comparisons will be transitive; numbers we get will be additive, have other properties of probabilities?

Consider "hunches" of "intuitionists": Keynes, Koopman, Good. partial ordering, vagueness, upper and lower probabilities in terms of n-scale.

Schlaifer

~~The author is~~ The analysis which it recommends is based on the modern theory of utilityand what has come to be known as the "personal" definition of probability; the author believes, in otherwords, that when the consequences of various possible courses of action depend on some unpredictable event, the practical way of choosing the "best" act is to assign values to consequences and probabilities to events and then to select the act with the highest expected value. p. v

From the point of view taken in this book, there is no real difference between a "statistical" decision problem in which a part of the available evidence happens to come from a "sample" and a problem in which all the evidence is of a less formal nature...one of the resulting advantages is that it becomes possible to avoid having to assert that nothing useful can be said about a sample which contains an unknown amount of vias while at the same time having to admit that in most practical situations it is totally impossible to draw a sample which does not contain an unknown amount of bias. v. In the same way and for the same reason there is no real difference between a decision problem in which the long-run-average demand for some commodity is known with certainty and one in which it is not.

...The author is quite ready to admit that in some situations it may be difficult for the businessman to assess the numerical probabilitie and utilities which are required for the kind of analysis recommended in this book, but... vi

Keynes on weight of evidence. He didn't relate to his doubts about complete ordering of events; but Koopman and Good make latter quantitativ in terms of upper and lower probs, and it seems likely that: a: feelings of uncertainty can always be represented in terms of upper and lower probs--instead of saying that probabilities don't exist in some cases--b: cases where there is a wide gap--cases where Keynes would have said that probs didn't exist--are cases of low weight of evidence, OR CONFLICT

Keynes: "Is our expectation of rain, when we start out for a walk, always more likely than not, or less likely than not, or as likely as not? I am prepared to argue that on some occasions none of these alternatives hold ((and that it will be an arbitrary matter to decide for or against the umbrella. If the barometer is high, but the clouds are black, it is not always rational that one should prevail over the other in our minds, or even that we should balance them--though it will be rational to allow caprice to determine us and to wasteno time on the debate.

But he either does or does not take the umbrella; we can infer probs from his actions. ~~But if expr~~ But will these show consistency? If caprice determines, will violate P1? This isn't fatal.

But if he uses other rules when confronted with upper and lower probs that overlap...

These other rules are ruled out by Savage axioms of preferences among actions; which do not refer to probabilities. Hypothesis: if he violates he will want to change.

Thus, observation of reflective actions promises to produce consistent judgements even though questioning might not.

THESE are the cases we want to test theory on; cases where it promises to do what Keynes, Koopman, etc. doubted could be done.

Red, Black.

Red, Black, Yellow.

Keynes on weight of argument: especially when it comes to choosing action.

"The question to be raised in this chapter is somewhat novel; after much consideration I remain uncertain as to how much importance to attach to it. The magnitude of the probability of an argument... depends upon a balance between what may be termed the favourable and the unfavourable evidence; a new piece of evidence which leaves this balance unchanged, also leaves the probability of the argument unchanged. But it seems that there